JACOBS
ESSSA Group

NASA

The 2016 Perseids

D. E. Moser
Jacobs ESSSA Group, Meteoroid Environment Office, NASA MSFC

W. J. Cooke
NASA, Meteoroid Environment Office, NASA MSFC

Stanford Meteor Environment and Effects Workshop
Stanford University, California, 14-16 July 2015

Overview

The Perseid meteor shower is a prolific annual shower, known to outburst.

At least 2 spacecraft have suffered anomalies potentially caused by meteoroid impacts during Perseid outbursts.

The Perseids may outburst again in 2016. Observing geometry favors Russia/Europe and North America.

Goal: Describe preliminary predictions, encourage discussion and observation planning.

Perseid background info

Parent comet: 109P/Swift-Tuttle

Peak: Max. around Aug 11-13

Activity range: Jul 17 – Aug 24

Speed: 59 km/s

Radiant: $\alpha = 48°$, $\delta = +58°$ at peak

Typical ZHR: 100/hr

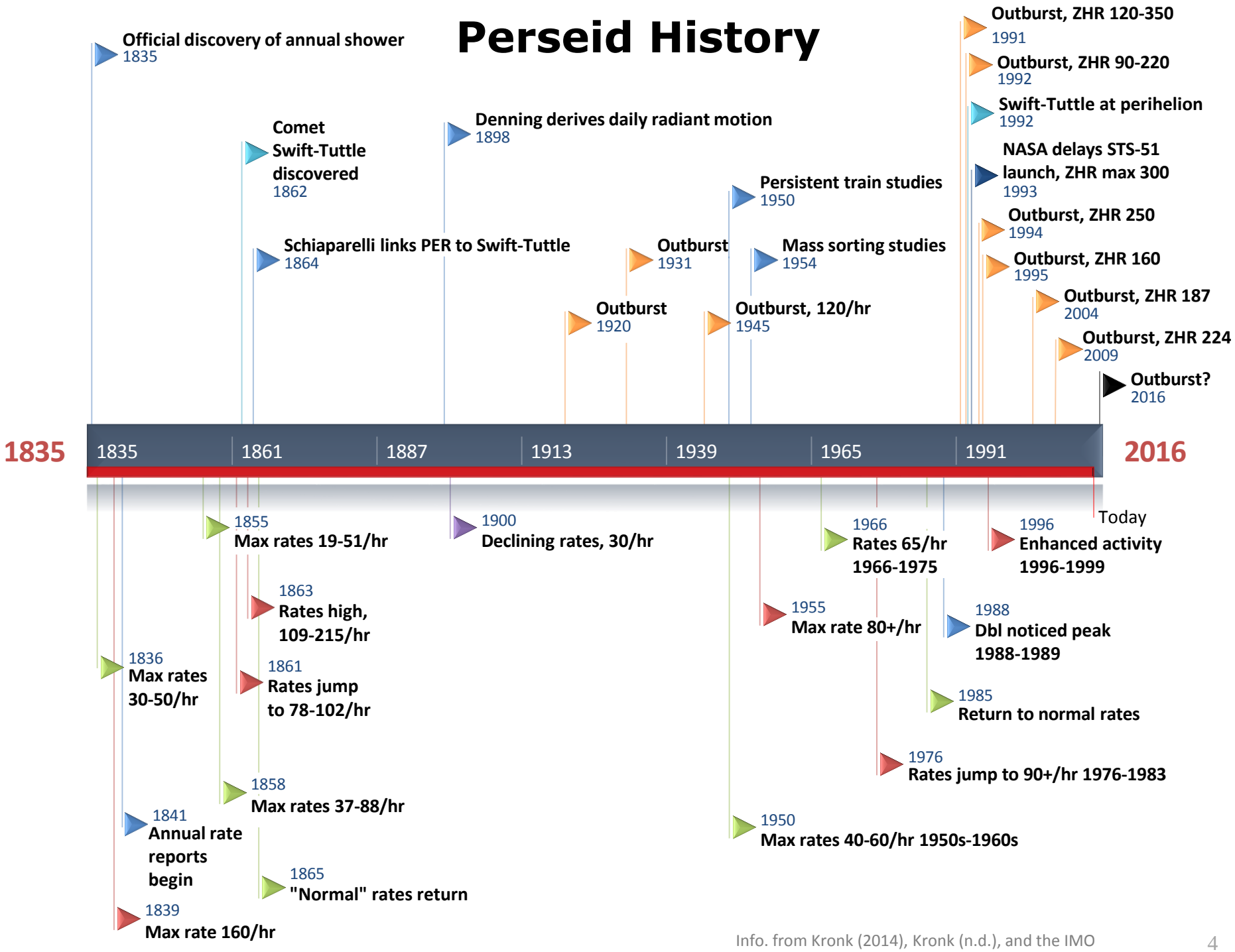
Recent major displays: 1991-1995, 2004, 2009

Features: Not known to storm, but can produce enhanced activity (100s meteors/hr)

Prediction history: Forecasts less accurate than those for Leonids

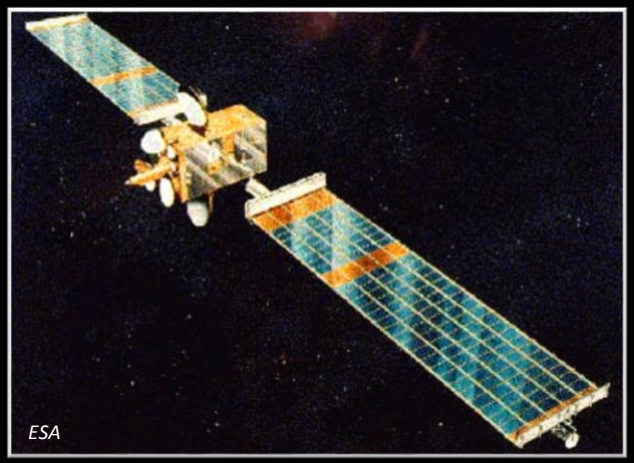
Perseid fireball recorded Aug 12, 2012

Perseid History



Info. from Kronk (2014), Kronk (n.d.), and the IMO

Spacecraft affected by Perseids



Olympus

ESA communication satellite

Struck by a Perseid near the time of the shower peak in August 1993

Sent tumbling, fuel exhausted, end of mission

Caswell et al. (1995)

Landsat-5

NASA/USGS imaging satellite

Struck by a Perseid near the time of the shower peak in August 2009

Sent tumbling, stabilized, returned to normal operations

Cooke (2009)

MSFC Meteoroid Stream Model

What

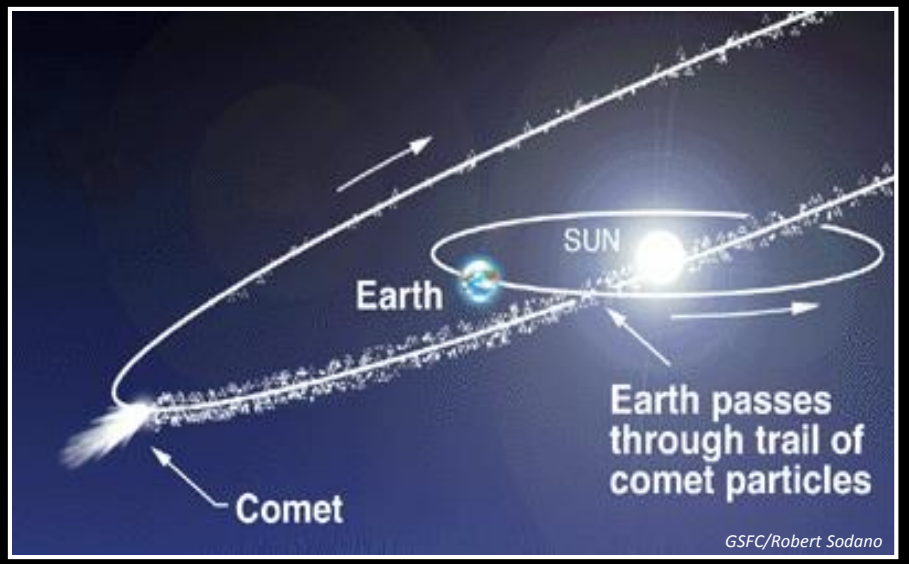
Model of particle ejection and subsequent meteoroid stream evolution from comets.

Why

To provide accurate meteor shower forecasts to spacecraft operators for hazard mitigation and mission planning purposes.

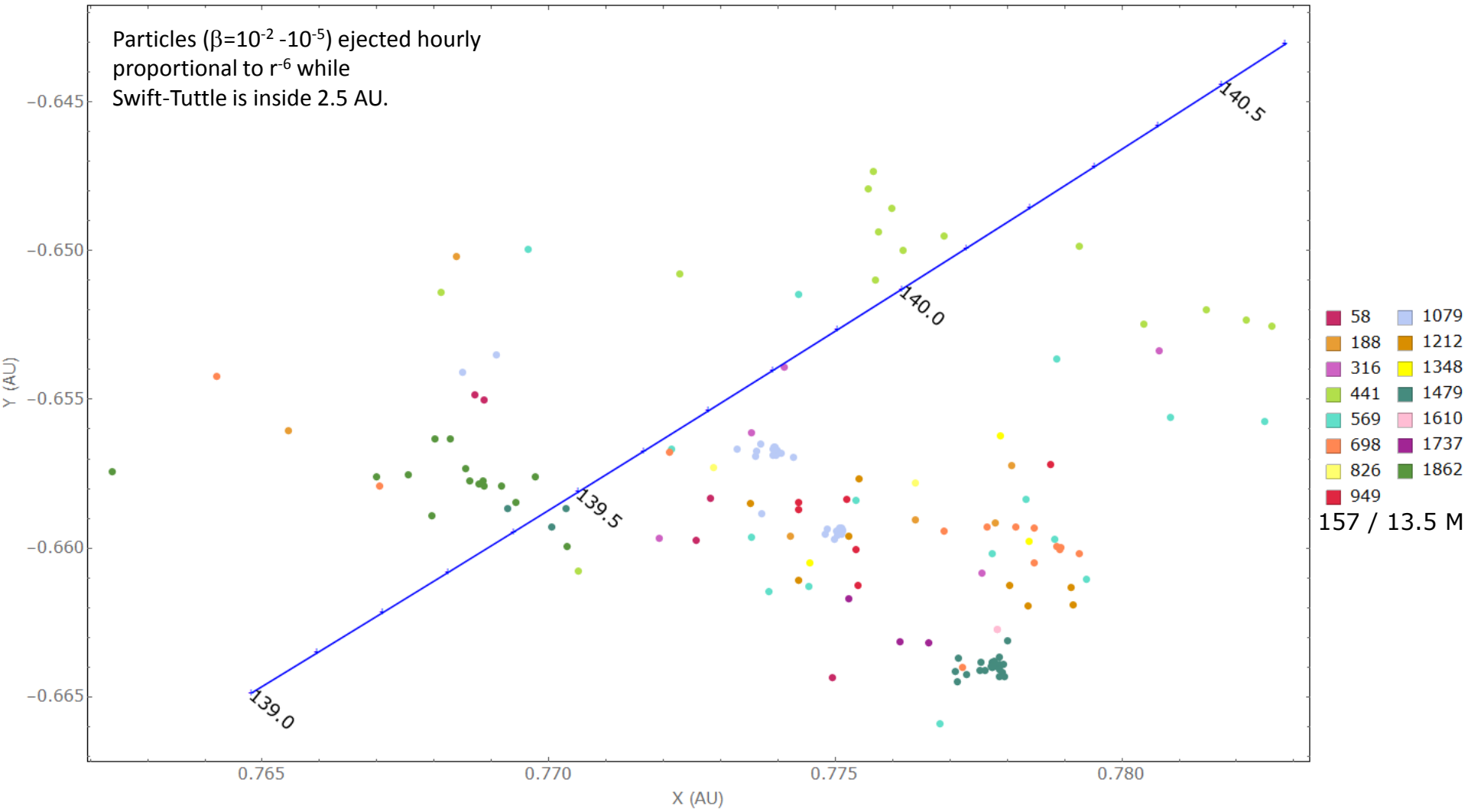
Who

International Space Station and science spacecraft.

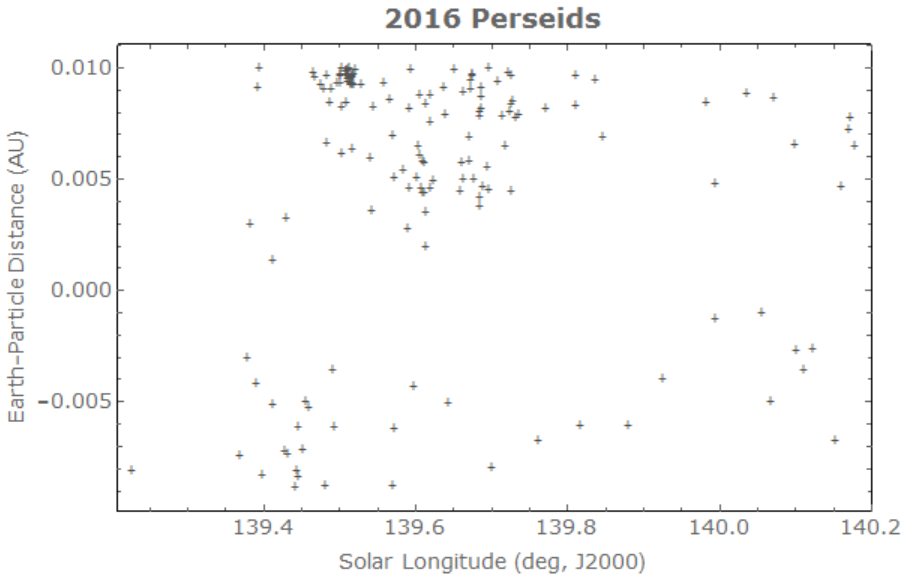


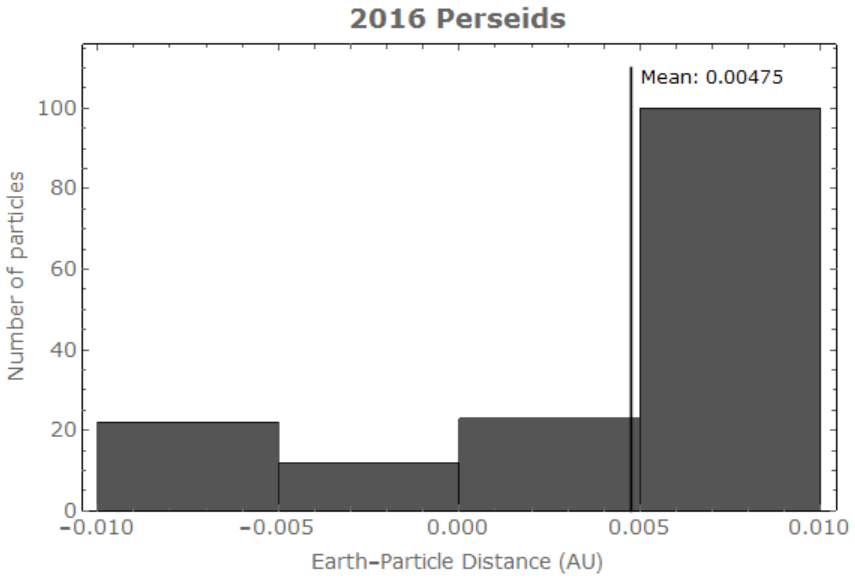
Meteoroid stream ejected from parent comet

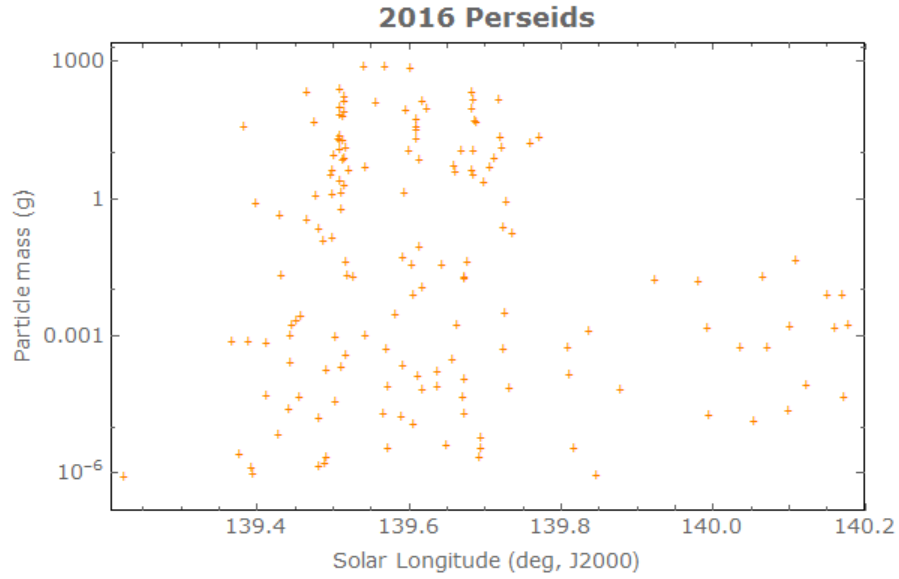
2016 Perseid model results: MSFC preliminary

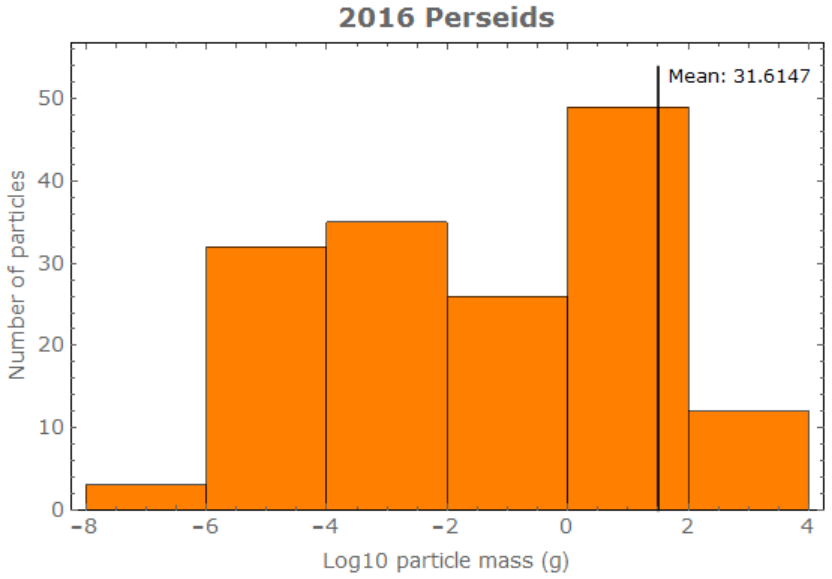


2016 Perseid model results: MSFC preliminary

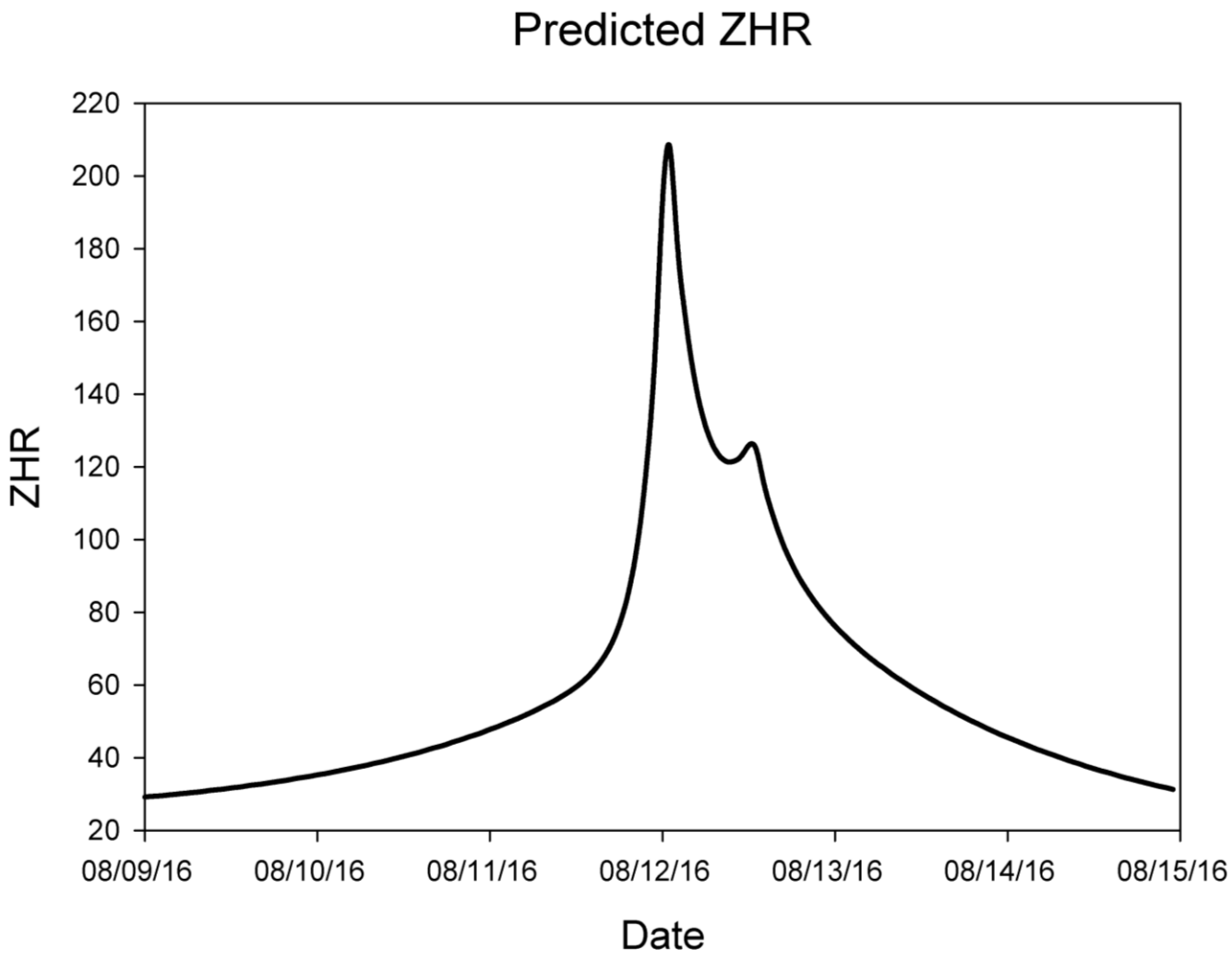








2016 Perseid model results: MSFC preliminary

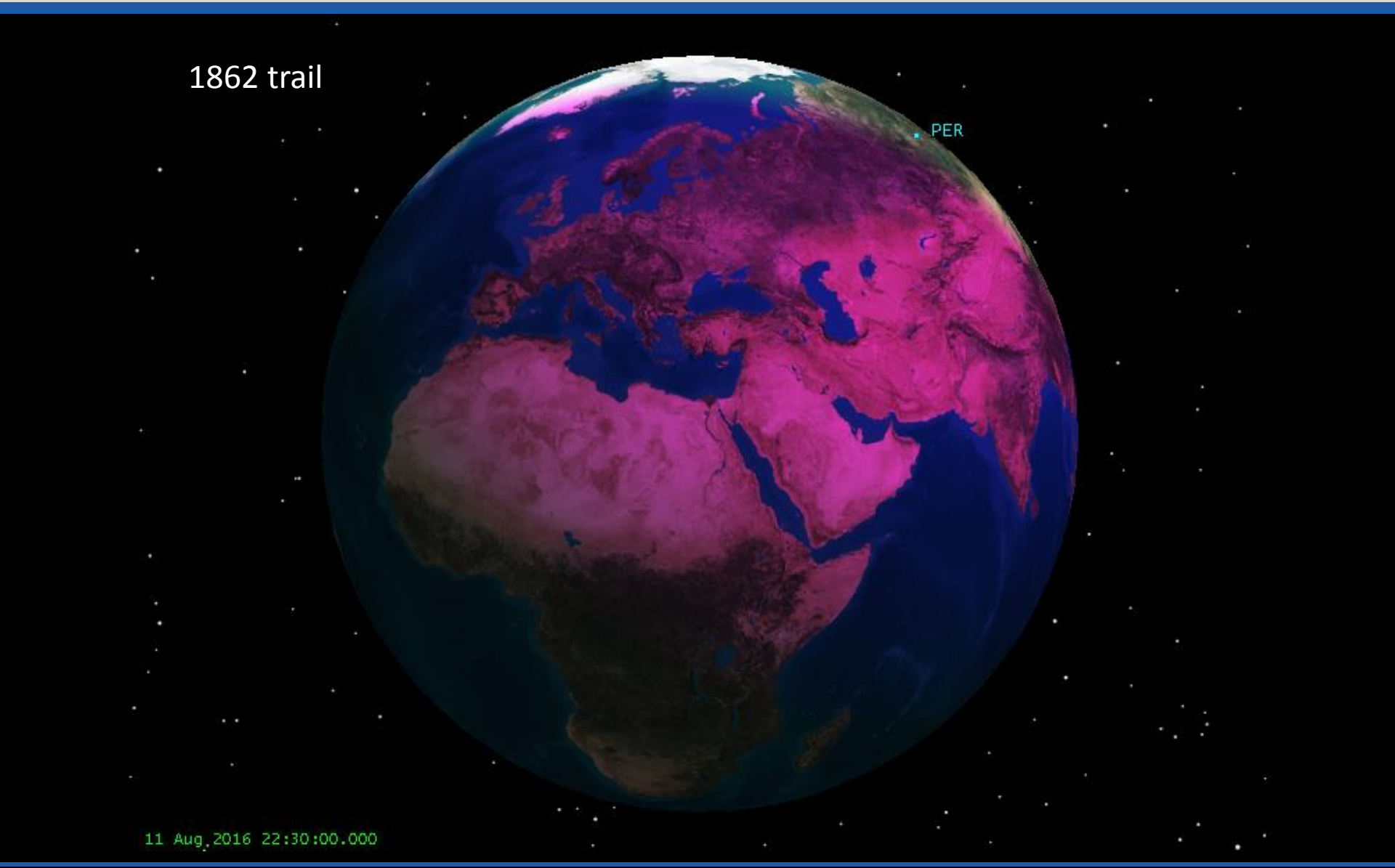


2016 Perseid model results - Summary -

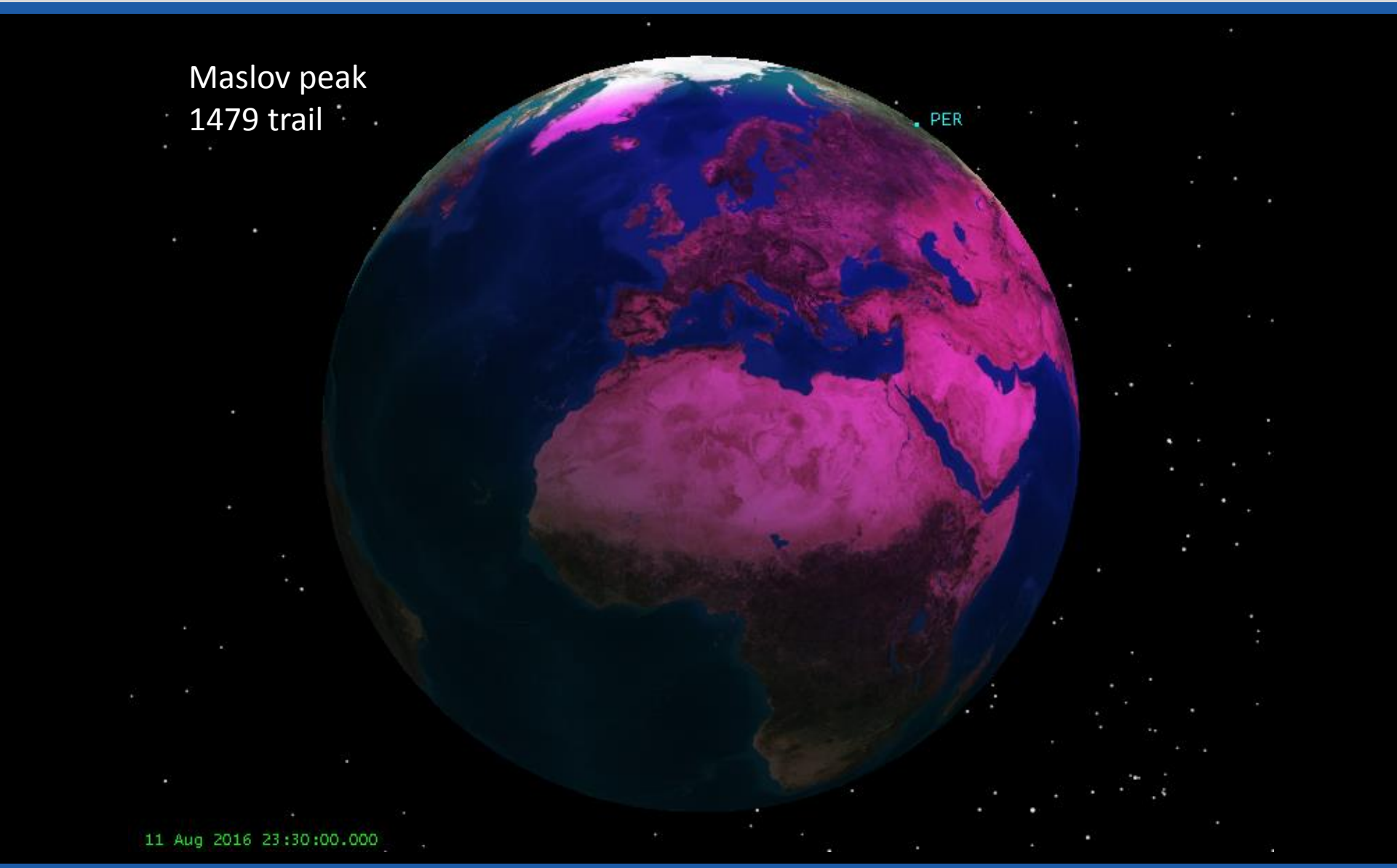
Modeler	Rev	Date	Time (UT)	λ_s (°)	ZHR	r_d-r_E (AU)
Maslov (web, undated)	1862	Aug 11	22:34	139.436	?	-0.00134
Vaubaillon (Jenniskens, 2006)	1862	Aug 11	22:36	139.438	1	-0.00327
MSFC single rev (June 2015)	1862	Aug 11	22:47	139.445	-	-0.00170
Maslov (Rao, 2012)	-	Aug 11	23:23	-	160-180	-
Maslov (web, undated)	1479	Aug 11	23:23	139.468	?	0.00008
Vaubaillon (Rao, 2012)	-	Aug 12	~00:00	-	"Unusually high activity"	-
Main MSFC (June 2015)	**Combined** 15 revs	**Aug 12**	**00:32**	**139.515**	**210 ± 50**	-
MSFC single rev (June 2015)	1079	Aug 12	04:36	139.678	-	0.00194
Vaubaillon (Jenniskens, 2006)	1079	Aug 12	04:43	139.683	580	0.00023
MSFC single rev (June 2015)	441	Aug 12	13:03	140.016	Comprises secondary peak?	-0.00046

Increased activity lasts about half a day, from late-Aug 11 to mid-Aug 12.

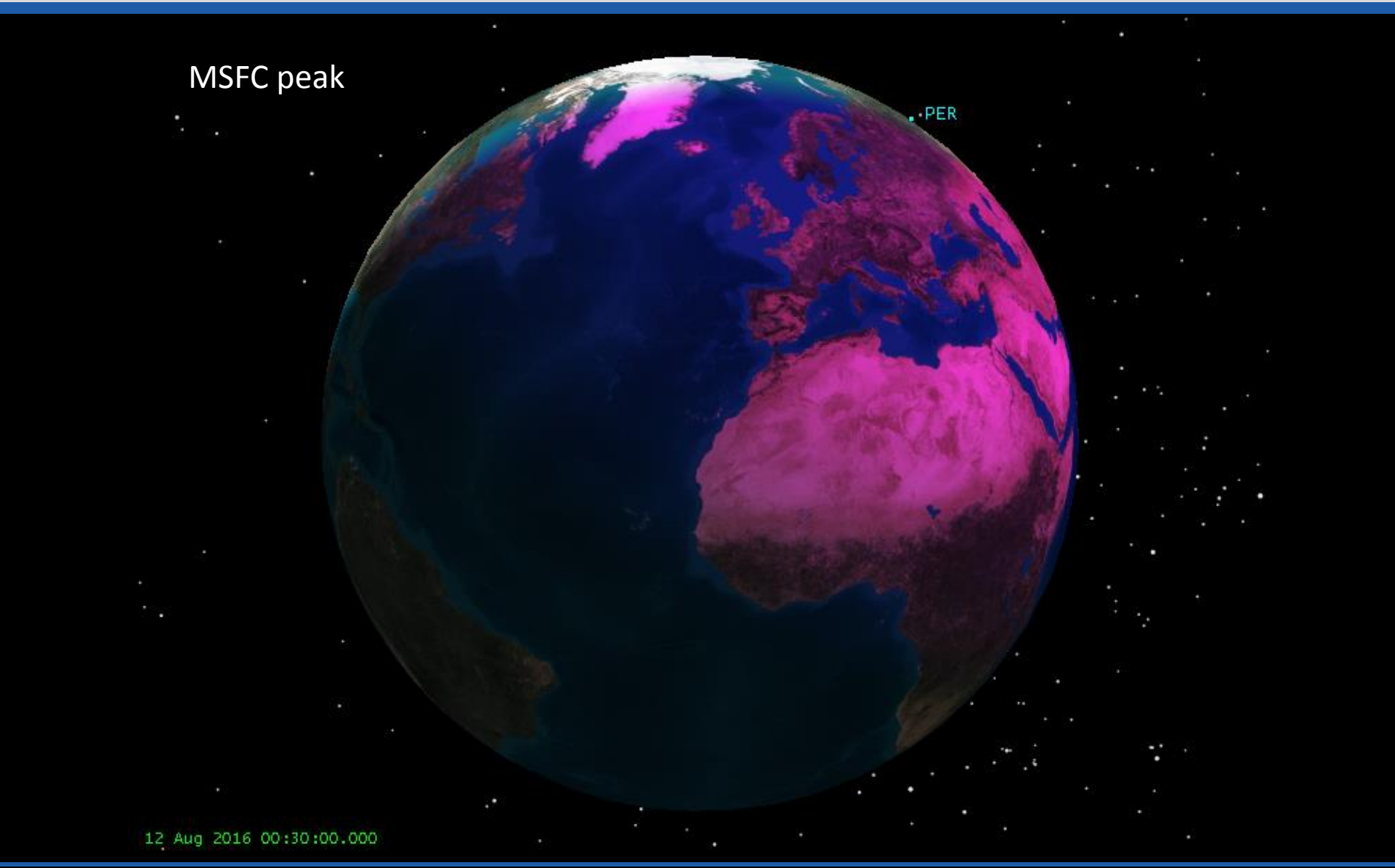
Observing geometry



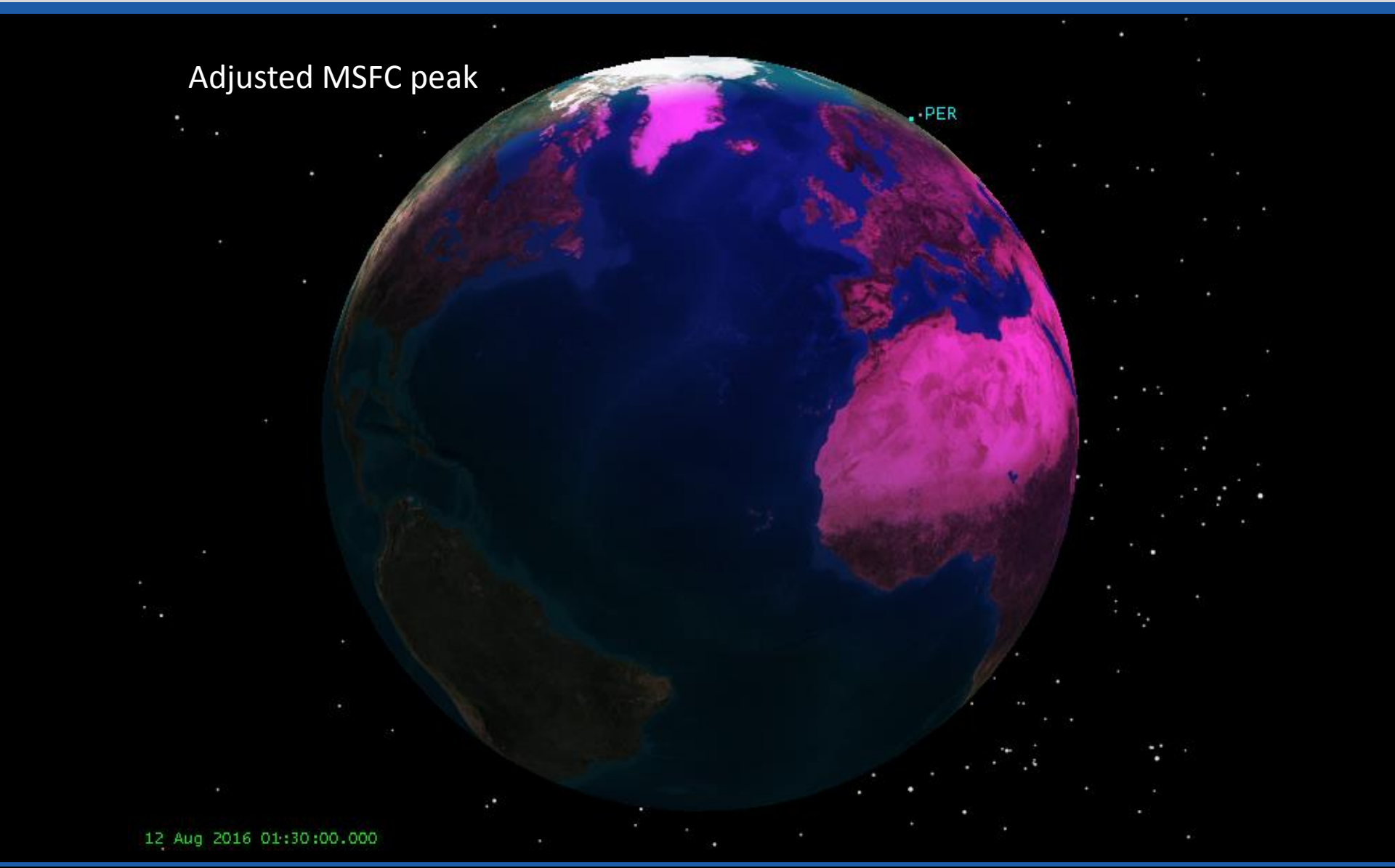
Observing geometry



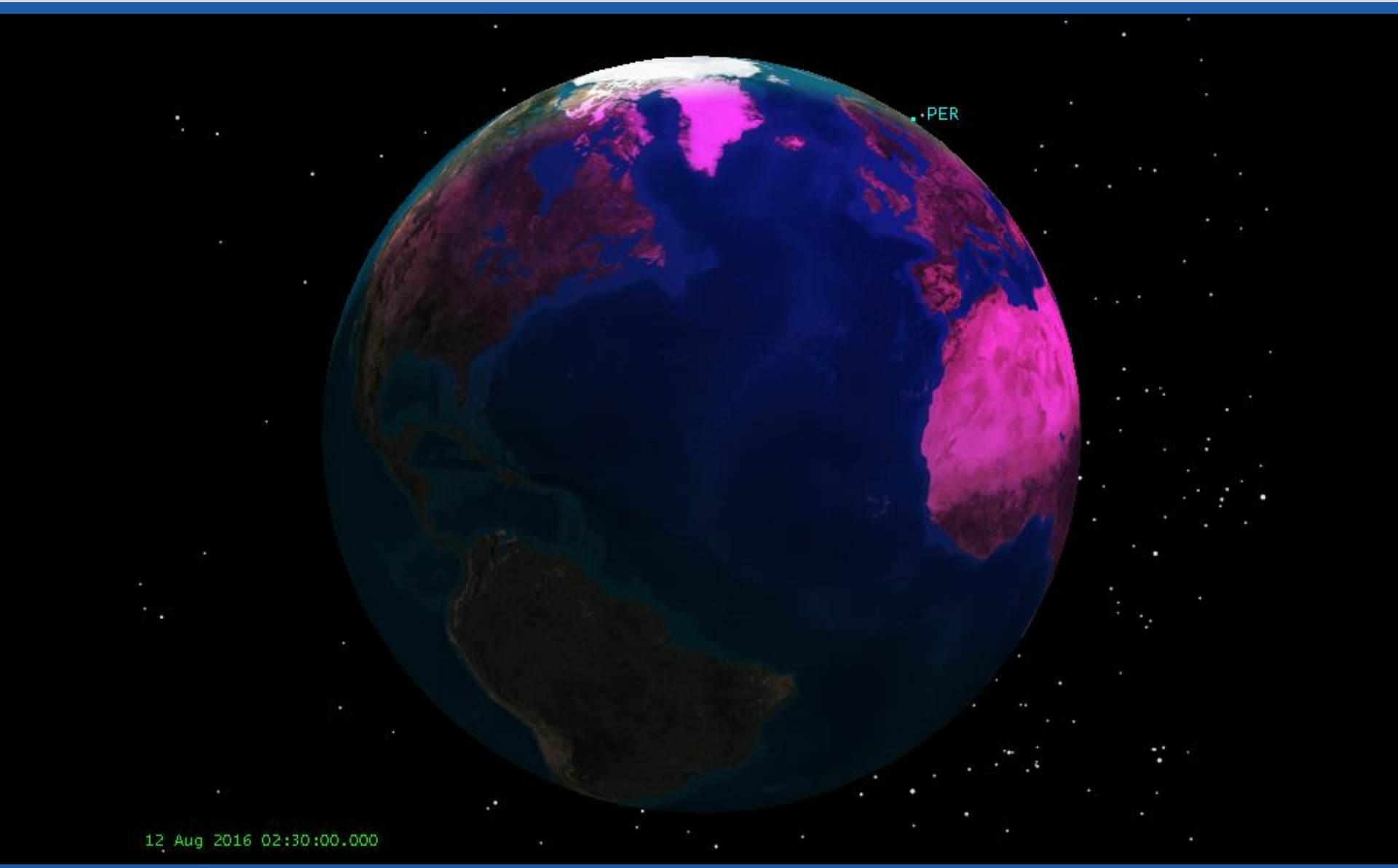
Observing geometry



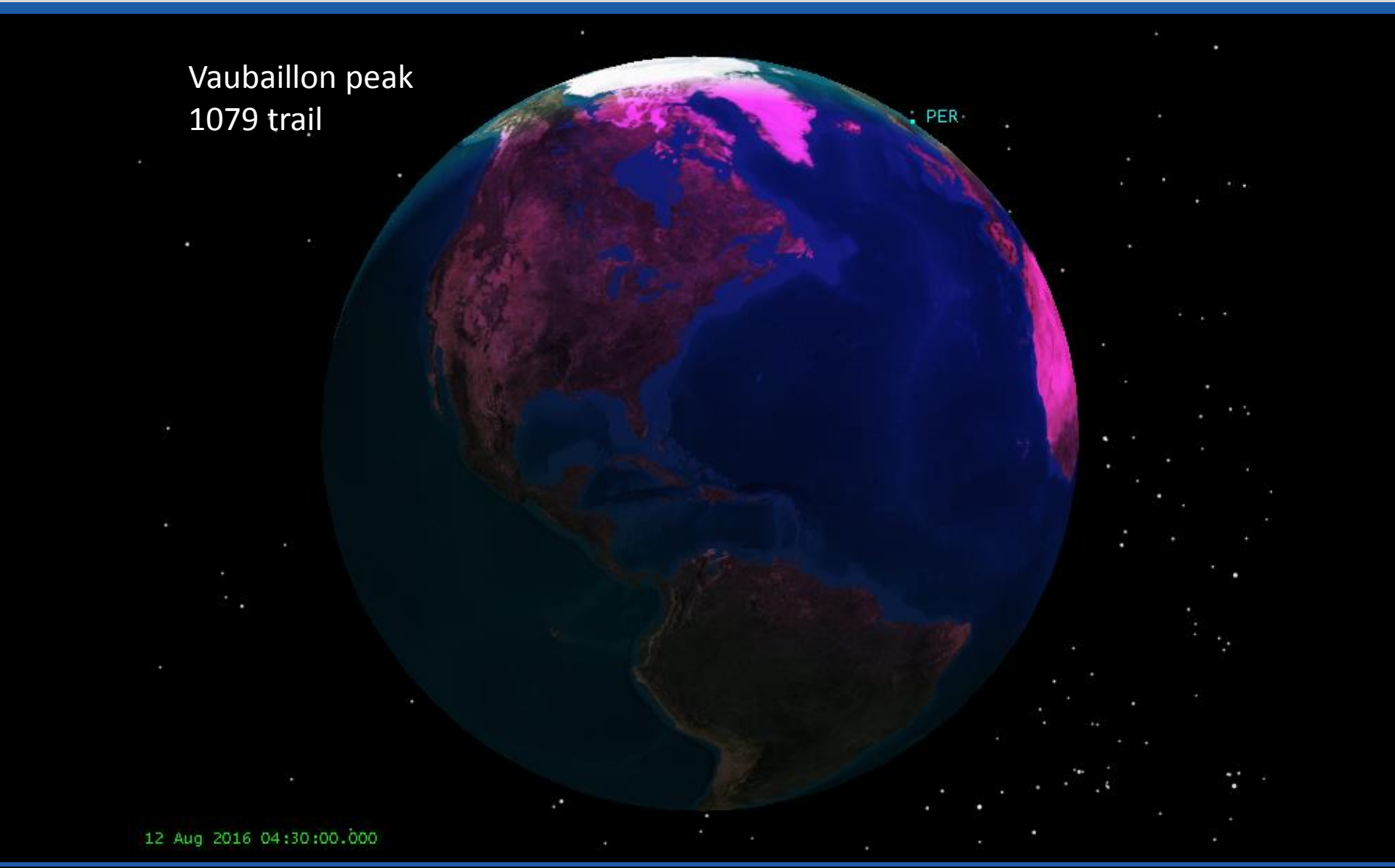
Observing geometry



Observing geometry

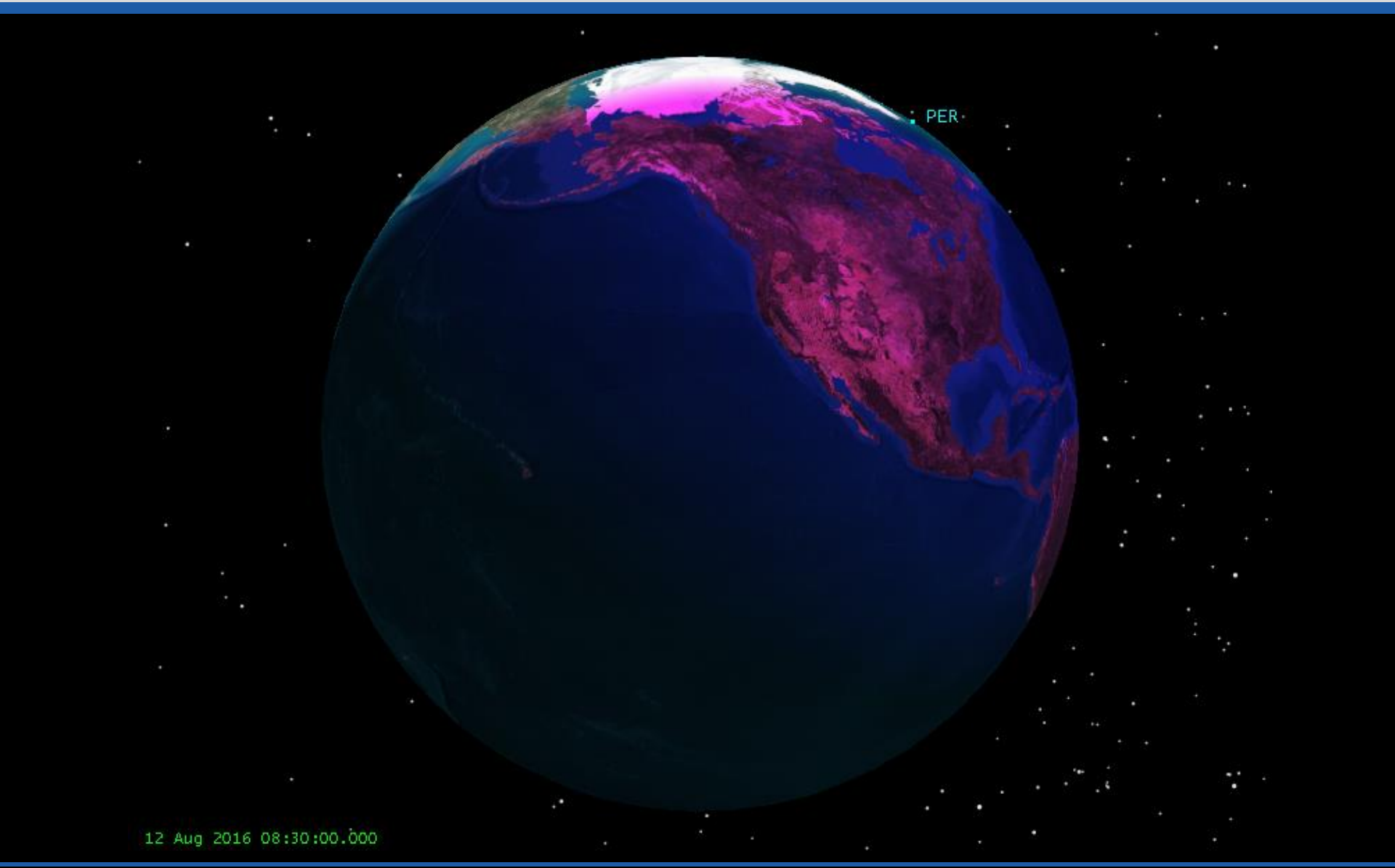


Observing geometry

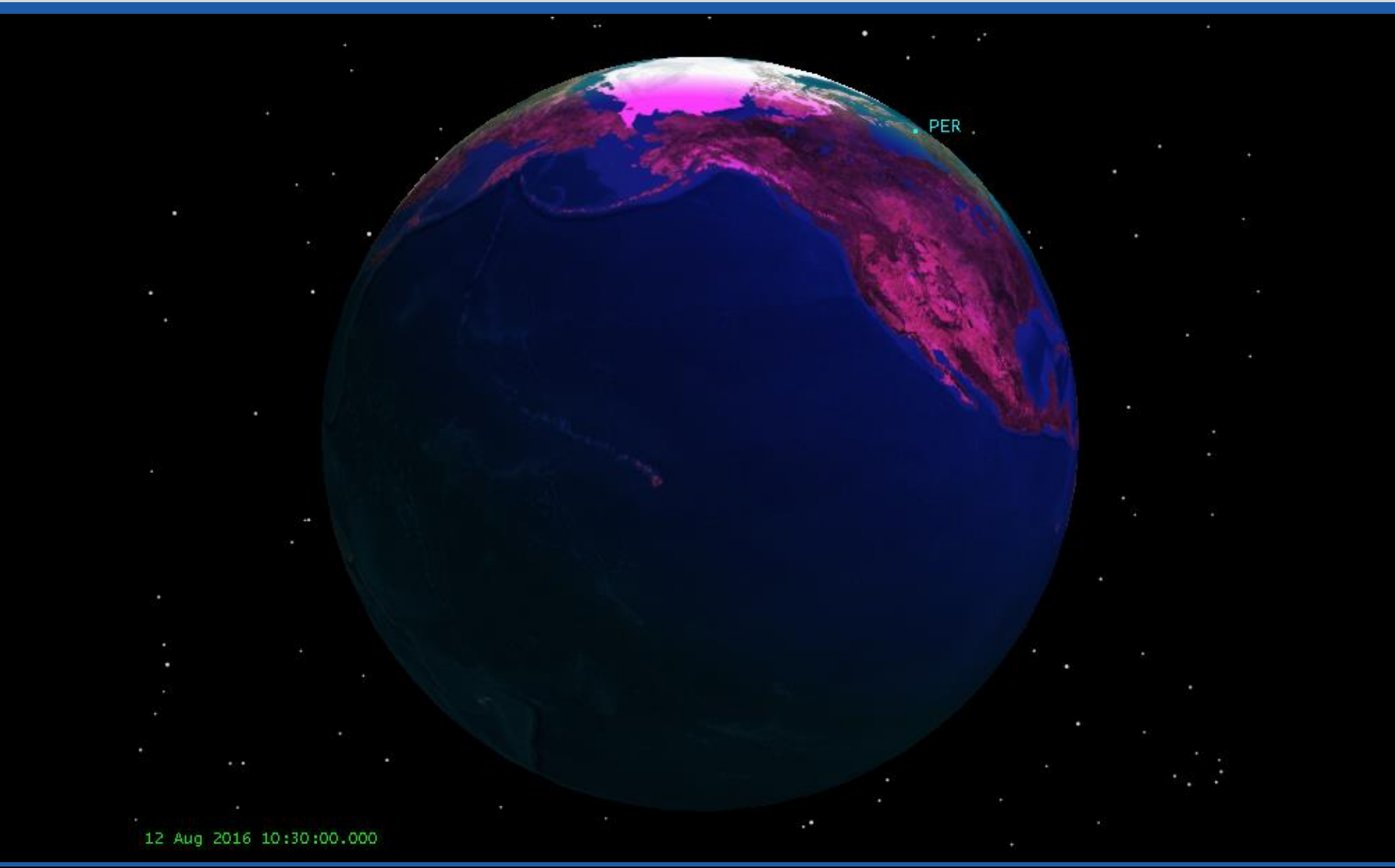


Observing geometry

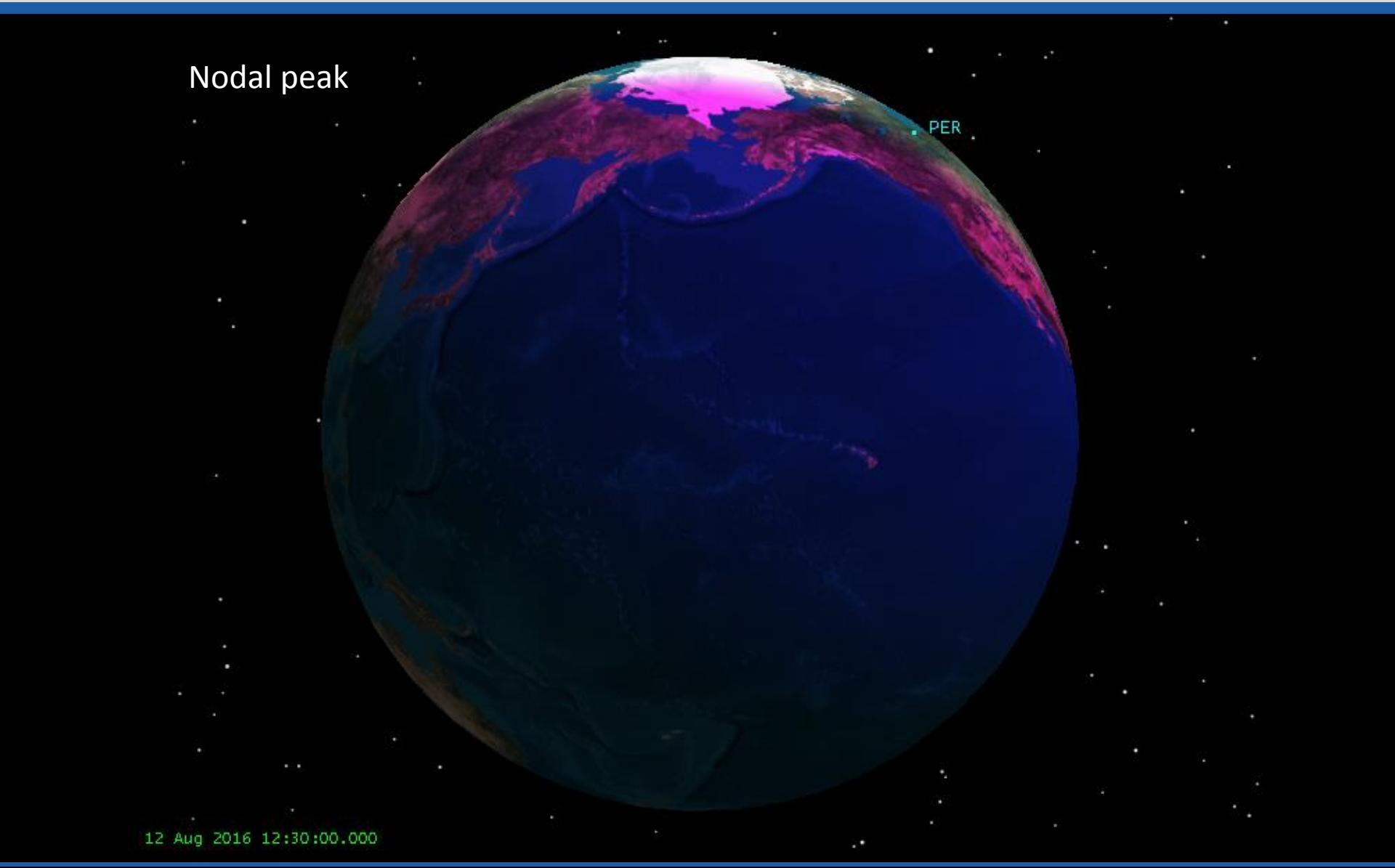
Observing geometry



Observing geometry

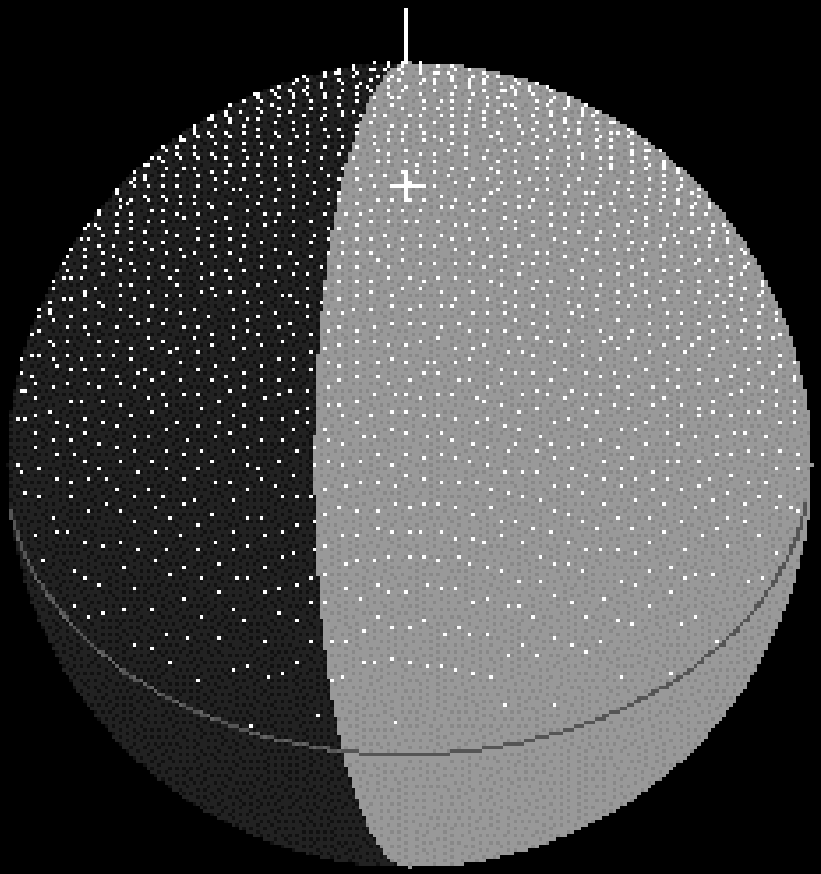


Observing geometry



Lunar observing geometry

Perseids
Aug 12 at 00:00 UT

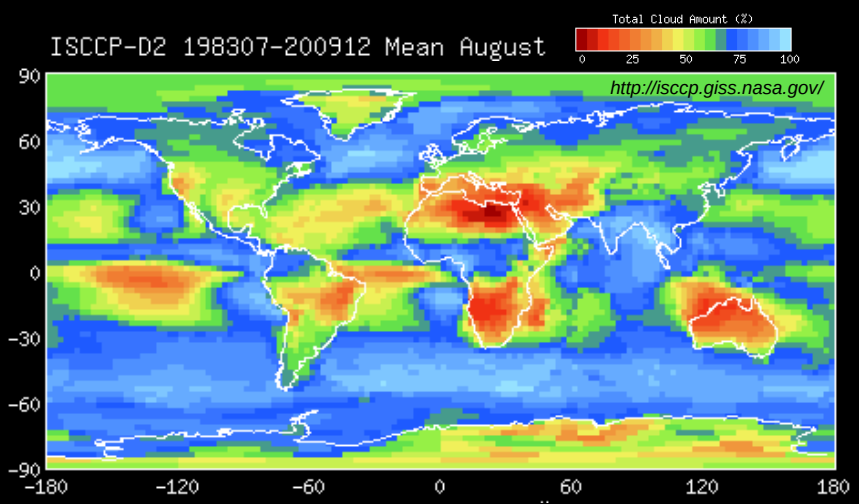


LunarScan output
(Gural 2007)

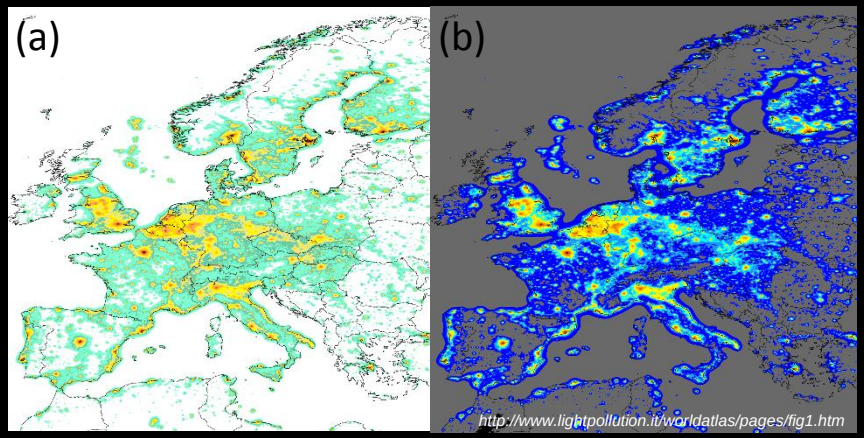
- Phase not good (62%) for lunar impact observing during the peak. (First Quarter on Aug 10.)
- Moonset around 12-1 am local time.

General camera deployment considerations

- Predicted peak observable
  - Night time for optical cameras
- Radiant high in the sky
  - Higher radiant = better rates
  - Keep radiant alt. >15° for the max. amount of time
- Good weather
- Minimal light pollution
- Mobility
  - Don't deploy cameras to islands, valleys, etc.
  - Choose area with well-connected road systems
- Choose camera pointing directions to max. collecting area

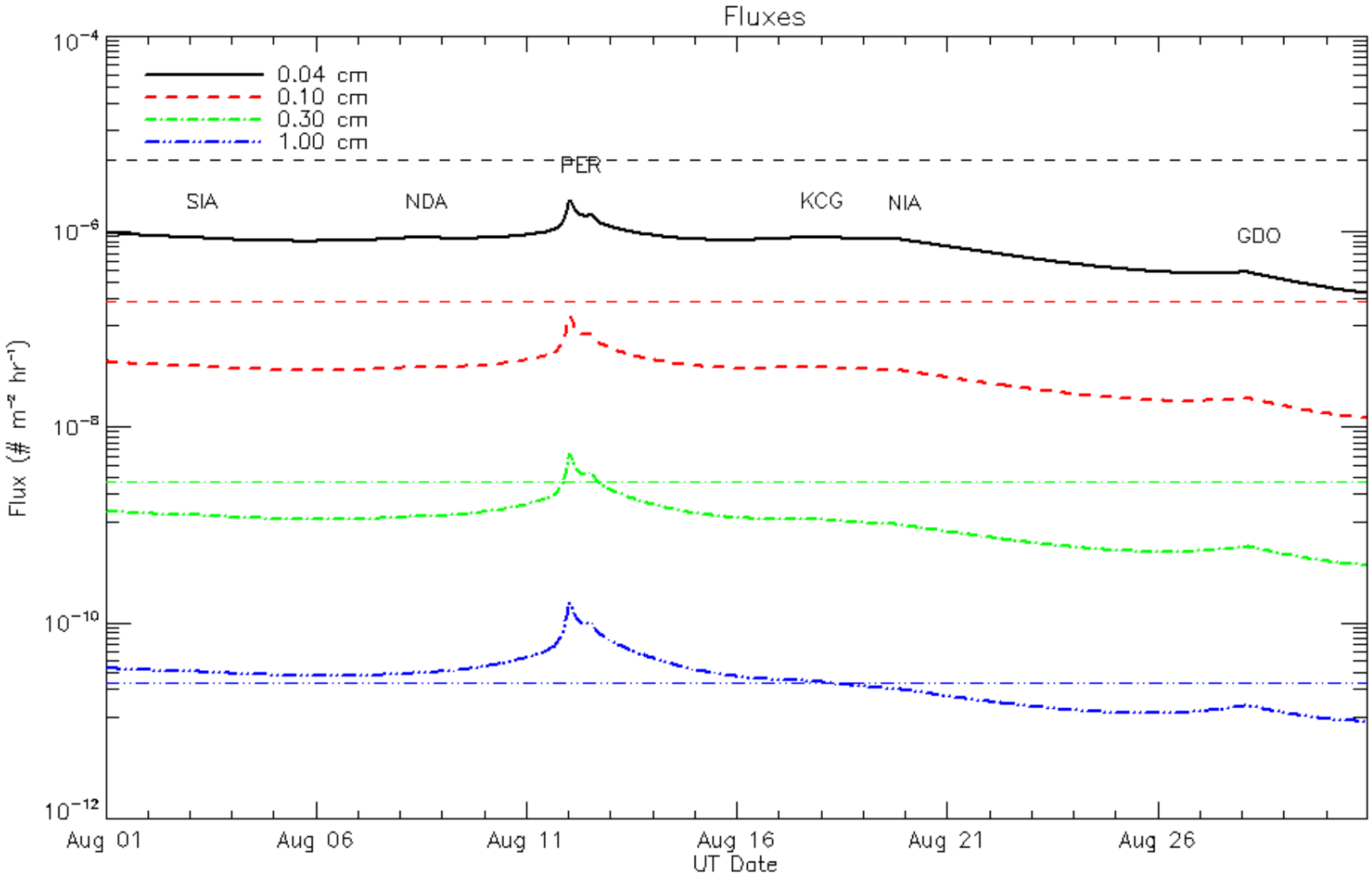


Average August cloud data (day & night)



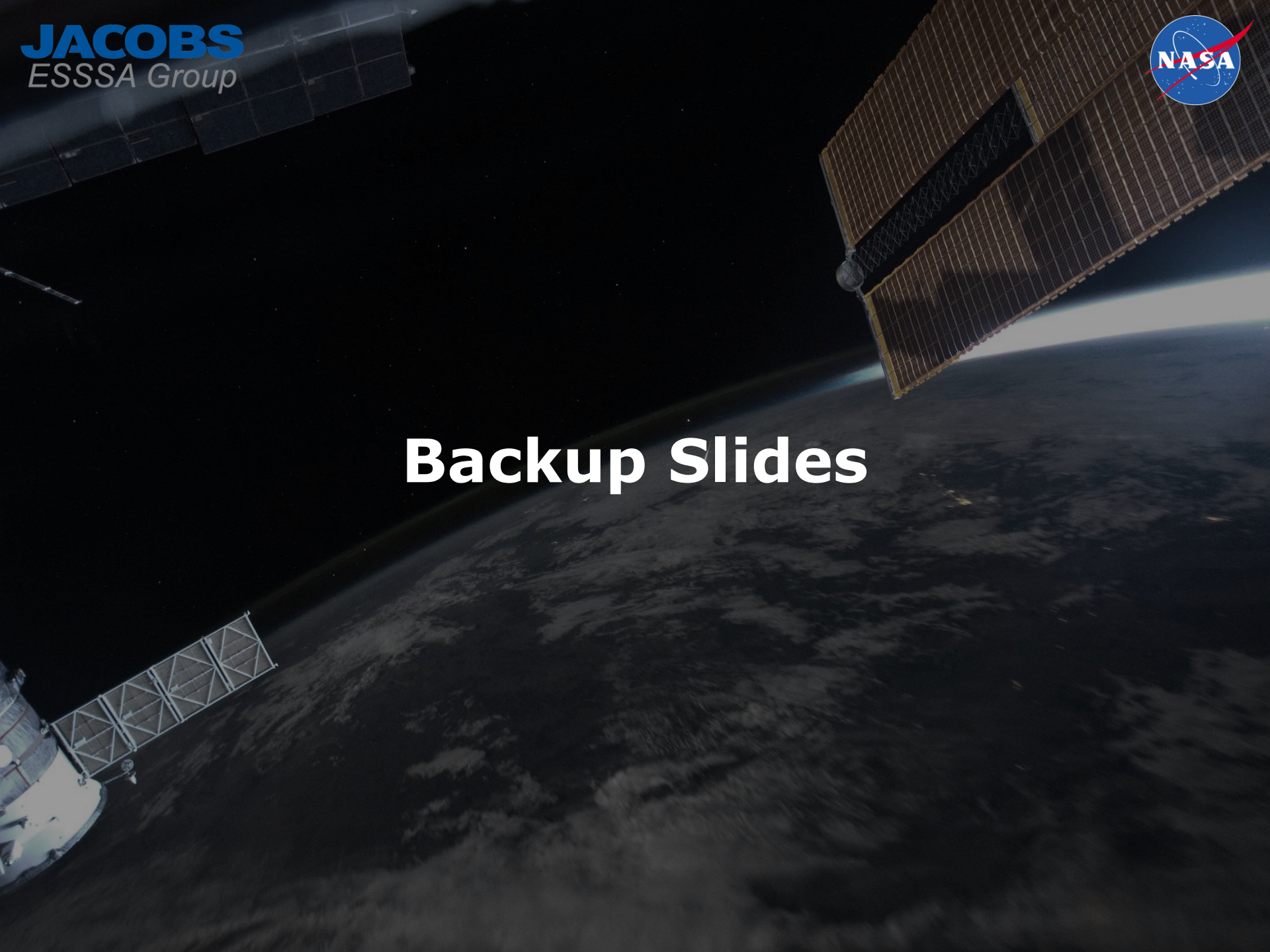
(a) Total night sky brightness acct. for alt., at zenith
(b) Naked eye star visibility (V mag)

Spacecraft risk

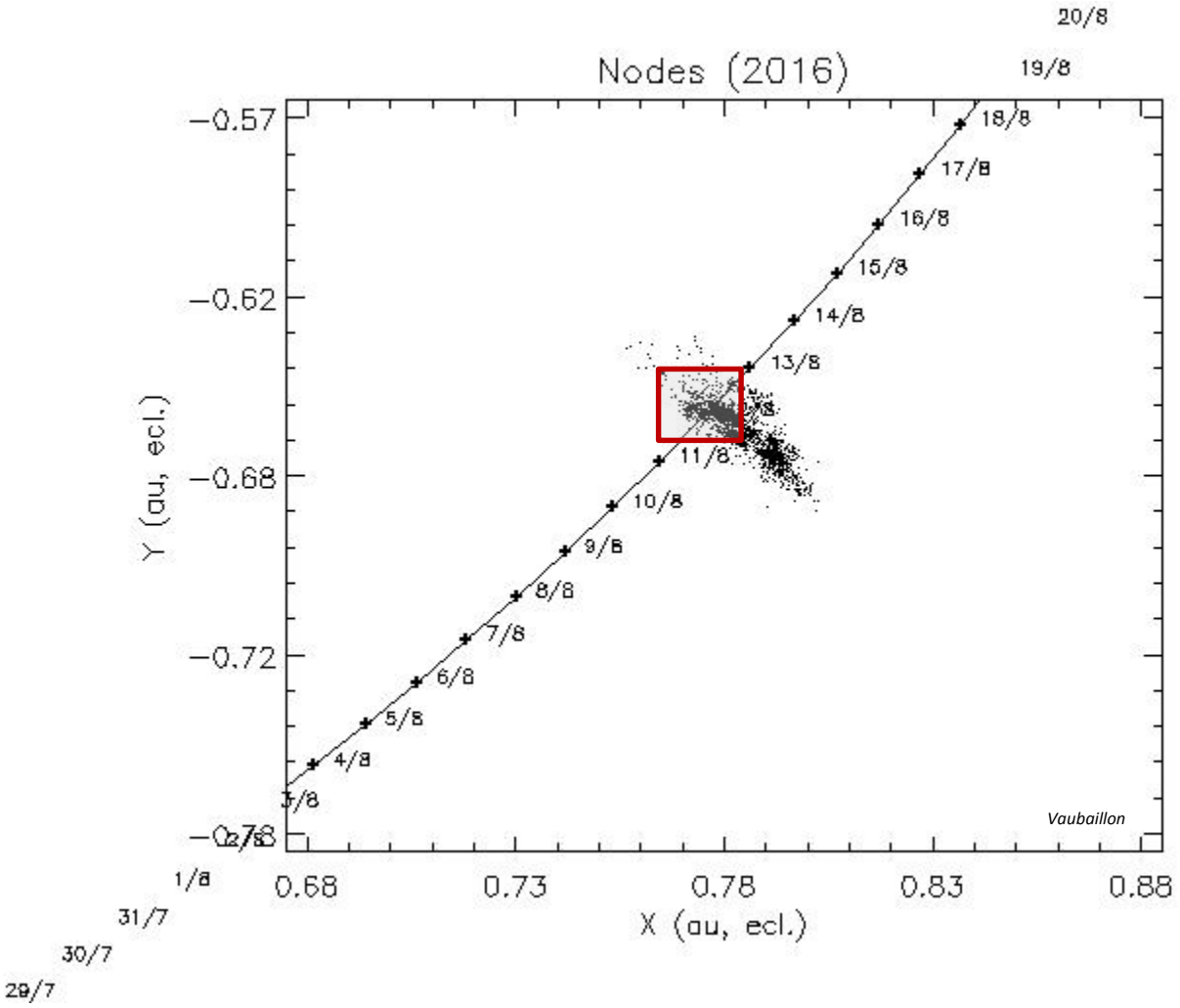


Summary

- The Perseids may outburst in 2016.
- Increased activity predicted late Aug 11 – Aug 12, lasting ~half a day.
  - Rates predicted between 160 – 580/hr.
  - Observing best from Russia & Europe, then North America.
- The outburst may represent a time of increased risk to spacecraft.


JACOBS
ESSSA Group
NASA
Backup Slides

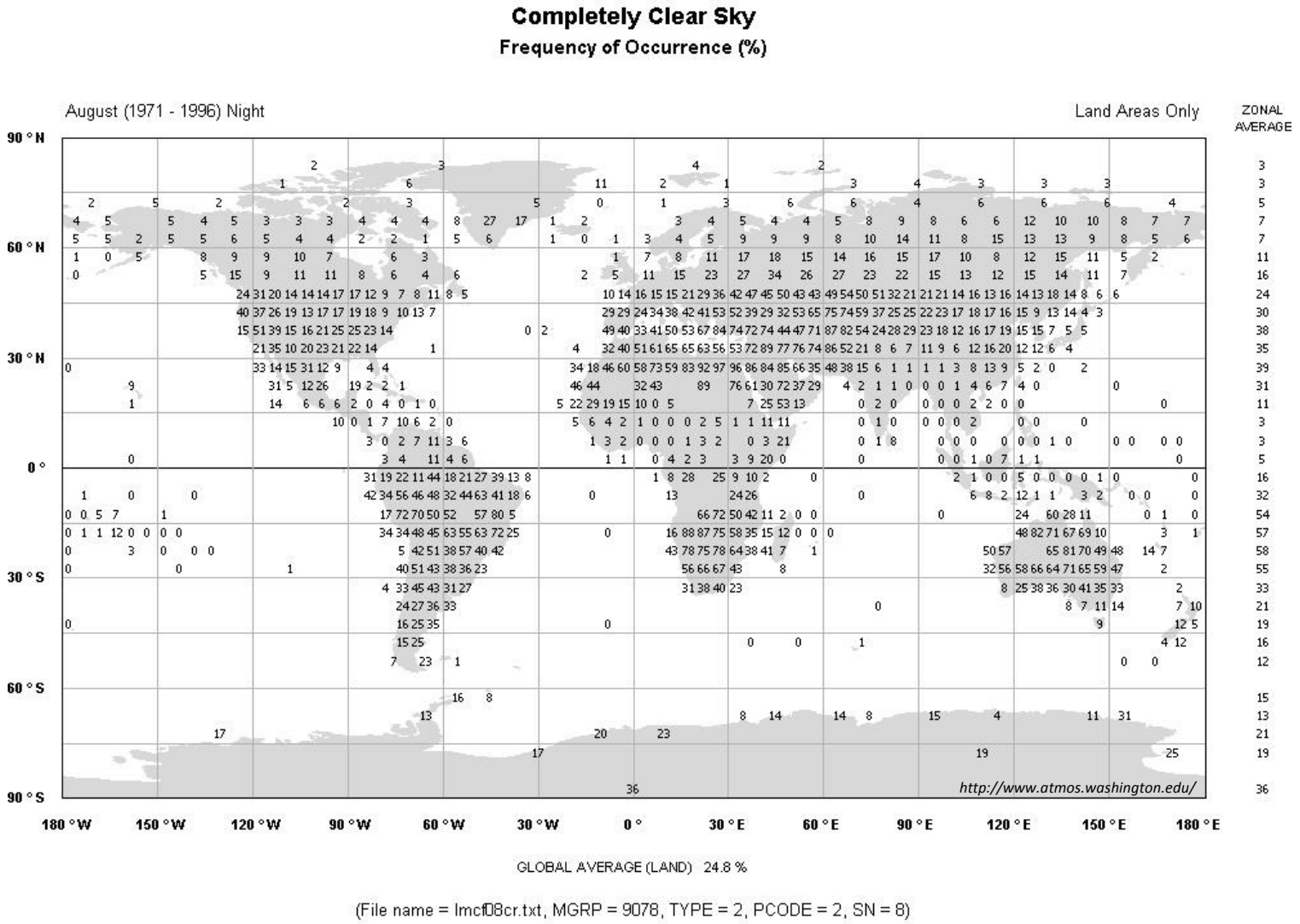
2016 Perseid model results: Vaubaillon



Approx. region covered by MSFC model

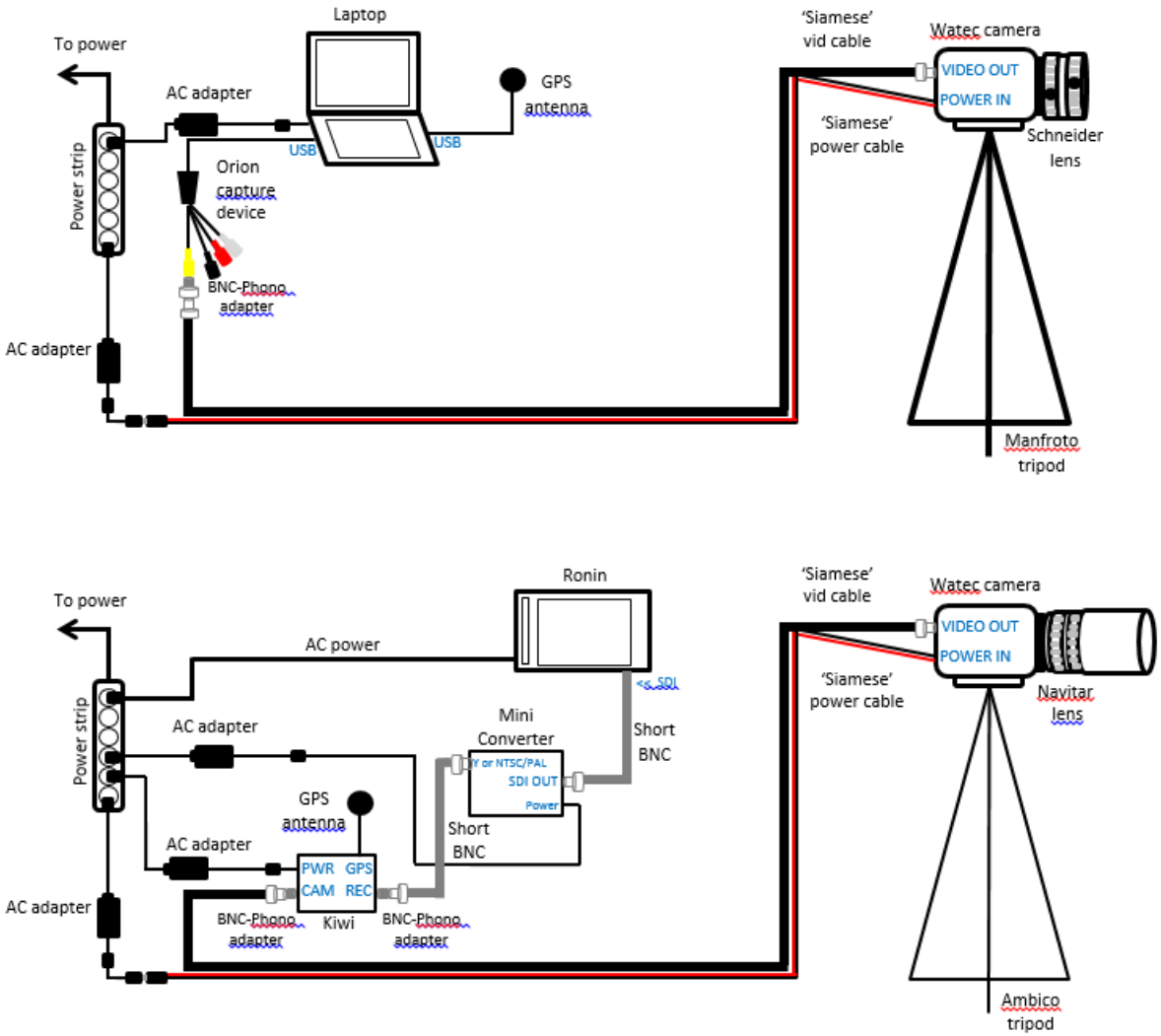
http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/Perseids/BIN-tout/Noeuds-Earth2016.jpg

Other weather data: Night only

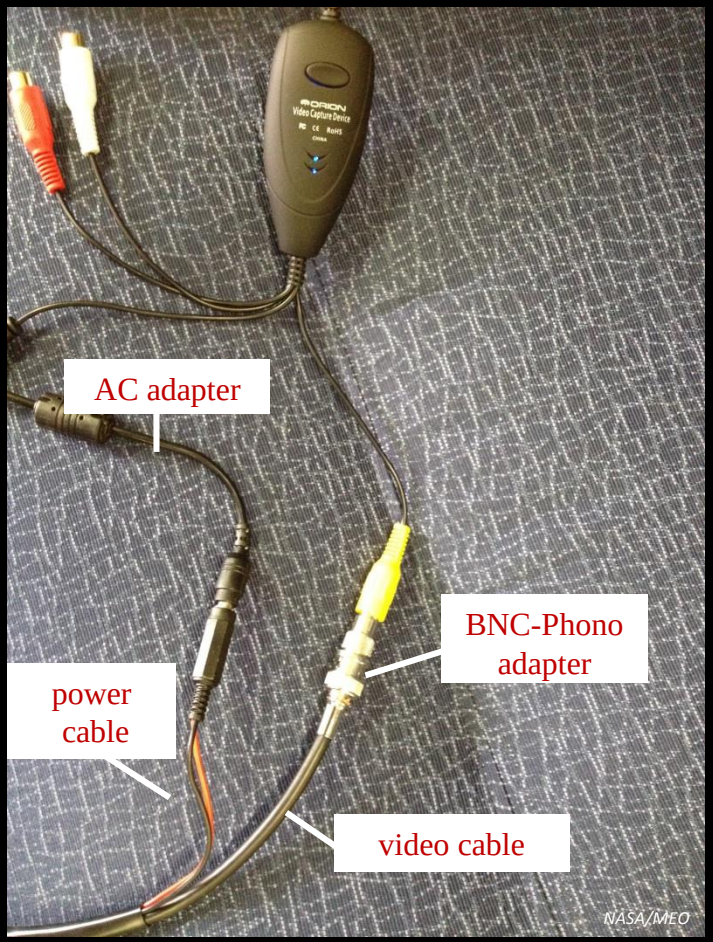


Past NASA deployment 2014 May Camelopardalids

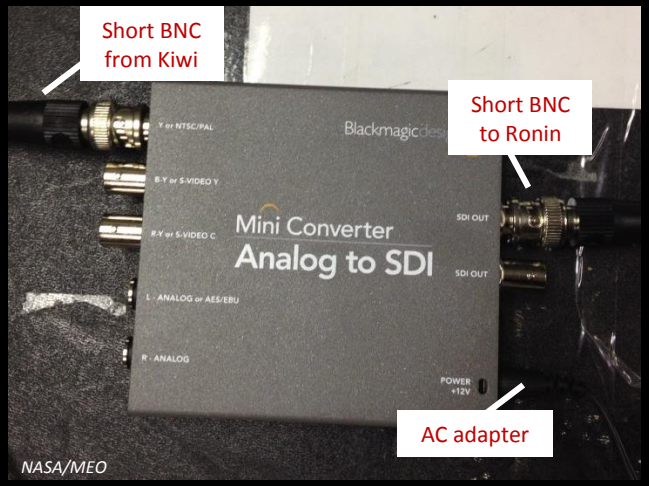
Deployed 2 cameras to northern Arizona



Past NASA deployment
2014 May Camelopardalids



Orion capture device



Analog to SDI converter

Ronin video display

Future outbursts

2020	Ursids
2022	τ-Herculids
2027	Perseids
2028	Perseids
2034	Leonids

References

Caswell, D. R. et al. (1995) "Olympus end of life anomaly – A Perseid meteoroid impact event?" Int. J. of Impact Engineering 17, 139-150.

Cooke, W. J. (2009) "The 2009 Perseid meteoroid environment and Landsat 5." NASA MSFC: NASA MEO Internal Report, 5pp.

Gural, P. (2007) "Automated detection of lunar impact flashes." Paper presented at 2007 Meteoroid Environments Workshop, NASA Marshall Space Flight Center, Huntsville, Alabama, 31 January – 1 February, 2007.

Jenniskens, J. (2006) "Meteor showers and their parent comets." Cambridge: Cambridge University Press, p.657.

Kronk, G. (n.d.) "Meteor showers online: Perseids." http://meteorshowersonline.com/perseids.html.

Kronk, G. W. (2014) "Meteor showers: An annotated catalog." New York: Springer-Verlag, 362pp.

Maslov, M. "Perseids 1901-2100: predictions of activity." http://feraj.narod.ru/Radiants/Predictions/1901-2100eng/Perseids1901-2100predeng.html.

Rao, J. (2012) "August Perseid meteor shower has long legacy, bright future." Space.com, 3 August 2012, http://www.space.com/16915-perseid-meteor-shower-2012-history.html.

Vaubaillon, J. "Nodes (2016)" http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/Perseids/BIN-tout/Noeuds-Earth2016.jpg